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# PRODUCTION OF BUCKWHEAT LEAF MEALS WITH HIGH RUTIN CONTENT

By J. Naghski, B. A. Brice and C. F. Krewson *

IN recent years, buckwheat has been displaced as a domestic source of rutin by the dried flower buds of the Chinese Scholar tree (*Sophora japonica*) (4), imported from China. This situation occurred mainly because the dried buckwheat meals available commercially were whole-plant meals of low rutin content (2 to 3%), which could not compete with the Sophora, which contained from 12 to 16% rutin. The embargo on trade with China has cut off supplies of Sophora, and drug manufacturers are greatly in need of new sources of material for rutin. To supplement their depleting stocks of Sophora, some manufacturers have started to import Eucalyptus leaves from Australia, which contain from 6 to 12% rutin. Eucalyptus, however, not only has the disadvantage of being an imported material but at present it is also undoubtedly the surplus from the needs of the United Kingdom, and shortages may develop as their demand for rutin increases.

Thus it is evident that an improved domestic source of rutin is highly desirable. Discussions with some of the rutin producers have revealed the following information: (1) they appear desirous of a dependable domestic source of raw materials; (2) they state that a domestic product containing 5 to 8% of rutin, if a dependable supply was available, would compete successfully with Sophora or Eucalyptus at their present market prices; and (3) they state that the available supplies of Sophora and Eucalyptus are just enough for the present demand for rutin but would be insufficient if the demand were to rise sharply.

Results of recent studies indicate that buckwheat can be produced that would meet these requirements. Buckwheat leaf meals containing more than 5% rutin, which have not heretofore been available commercially, have been prepared on a pilot plant scale (10)**. To do this commercially, however, will require some modification of the

* Eastern Regional Research Laboratory, Philadelphia 18, Pennsylvania, one of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, United States Department of Agriculture.

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present commercial drying procedures and more careful attention to growing conditions and maturity of the buckwheat.

It is the purpose of the present publication to review and emphasize the factors contributing to high rutin content of buckwheat and leaf meals; to point out that all the available knowledge on this subject has not been applied commercially, and to suggest means of further increasing the rutin content of this domestic material.

## Preparation of Dried Buckwheat Leaf Meal

Rutin can be extracted from either the fresh green immature plant or from a meal prepared by drying and grinding the green plant (8). Fresh plants have the disadvantage of being available only during the limited growing season, whereas the dried product can be stored for year-round production. Early work (3) showed, however, that buckwheat had to be dried carefully to prevent excessive destruction of the rutin.

*Fractional Drying:* The finding that the major portion of the rutin was located in the leaves and blossoms of the immature buckwheat (3) suggested that rutin could be concentrated by the preparation of a leaf meal. Eskew and co-workers worked out in detail a procedure for producing a dried leaf meal, using either a belt (6, 7)* or a direct fired rotary drier (10)*.

The recommended procedure is to dry as quickly as possible and carry the drying only far enough to embrittle the leaves and flowers; the stems, being much thicker, remain moist and tough. The plants in this condition are subjected to mechanical action, which breaks the brittle leaves and flowers away from the stems and crushes them into fragments. This is accomplished by directing the fractionally dried buckwheat into a fan, which, acting somewhat as a hammer mill, strips the friable leaves from the limp stems. The fan also blows the material to a cyclone collector. From there it falls to a vibrating screen, which separates the stems from the leaf fragments. A bag filter is provided on the cyclone exhaust to recover rutin-rich fines.

The drying process has to be carried out under strictly controlled conditions to prevent excessive loss of rutin. Even under optimum conditions for fractional drying, 25 to 35% of the rutin is lost; if the buckwheat is totally dried, the destruction is somewhat greater. The

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degree of rutin destruction depends on the type of drier, the temperature and the variety of buckwheat used.

Although it is possible to hand-pick a leaf and blossom fraction which would have almost 80% rutin enrichment (9), this separation has not been done mechanically on a commercial scale. An evaluation of a number of leaf meals produced at this laboratory during the pilot plant study of drying conditions (Table I) showed that a 50% concentration of rutin could be produced over that which could be obtained when whole meals were prepared. This enrichment was more than enough to compensate for losses encountered during drying, and the leaf meals were richer in rutin than the starting fresh plant (9). Since in these studies only 60% of the stem material was discarded, there is a possibility that removing a greater proportion of the stems (10) would produce even greater concentration.

Field drying as an adjunct to artificial drying has been investigated (9, 10). Under favorable conditions as much as one-third of the water could be removed from normal buckwheat or one-half from unusually lush buckwheat without reducing the over-all recovery of rutin, provided that wilting was not carried far enough to reduce the moisture content below 78%. Wilting greatly increases the capacity of the drier and decreases the cost of fuel. Under unfavorable weather conditions when wilting was slow, however, an appreciable loss of rutin occurred.

*Relation of Buckwheat Variety to Rutin Content:* Buckwheat first used for production of rutin was the Japanese (*Fagopyrum esculentum*) (3), commonly grown for grain. Later work (5), however, showed that the little-known Tartary (*F. tataricum*) was superior in several respects. It was 45 to 80% richer in rutin, had a higher proportion of leaf, and yielded greater quantities of leaf per acre. Furthermore, Tartary is more frost resistant and so can be planted earlier in the spring. In addition to these cultural advantages, Tartary buckwheat is better suited for dehydrating. It can be dried at higher temperatures and with less critical control than the Japanese (7). Work with three additional varieties of buckwheat—Silver Hull, Tartary Tetraploid (11) and Emarginatum—indicated that, for rutin production, Tartary is also better than the Silver Hull and Emarginatum (12, 13). The Tartary Tetraploid (13) is similar to the Tartary in rutin content and yields and so has potentialities for rutin production; however, seed is not available in commercial quantities.

Table I.—Rutin Content of Leaf Meal Produced by Fractional and Total Drying of Tartary Buckwheat Plants [a]
(Moisture-free Basis)

| Sample No. | Corrected Values for Rutin in: Fresh Plant (A), % | Leaf Meal (B), % | Whole Meal [b] (C), % | Increased Concn. of Rutin in Leaf Meal,[c] % |
|---|---|---|---|---|
| 1 | 4.64 | 4.89 | 3.19 | 53 |
| 2 | 5.22 | 5.38 | 3.50 | 54 |
| 3 | 3.97 | 3.26 | 2.16 | 51 |
| 4 | 4.49 | 4.74 | 3.10 | 53 |
| 5 | 3.49 | 3.53 | 2.33 | 52 |
| | | Totally Dried | | |
| 6 | 3.89 | 3.46 | 2.29 | 51 |
| 7 | 4.81 | 4.03 | 2.65 | 52 |
| 8 | 2.89 | 1.73 | 1.20 | 44 |
| 9 | 3.28 | 3.15 | 2.09 | 51 |

[a] Samples obtained during the investigations on buckwheat drying by Phillips et al. (10).

[b] Calculated on the basis of discarding 37% of the dry weight as stems containing 0.3% rutin.

[c] $\frac{B - C}{C} \times 100.$

*Effect of Age of Plant and Time of Planting on Rutin Content:* Figure I shows the effects of age and time of planting on the rutin content of Tartary and Japanese buckwheat. It can be seen that buckwheat plants reach the peak of rutin content at the time of blooming which is about 25 to 35 days after emergence, depending on the species. The rutin content of all buckwheat decreases after seeds form. The decrease in rutin content of Tartary buckwheat is not so rapid or so great as that of the Japanese. Tartary both flowers and sets a full crop of seed more slowly. It does not mature so rapidly but grows continuously, maintaining a considerable portion of the plant as young immature tissue, which is always richer in rutin.

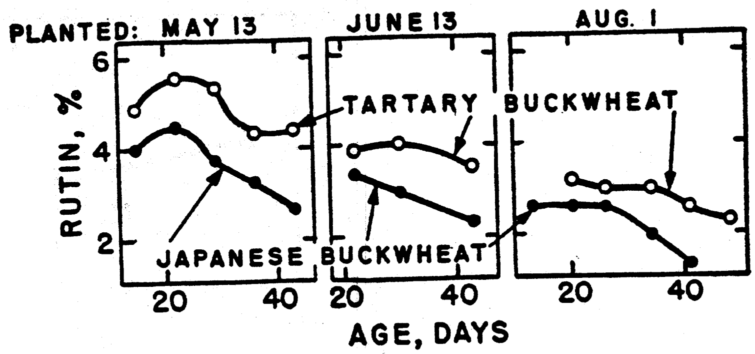


FIGURE I. Effects of Age of Plant and Time of Planting on the Rutin Contents of Japanese and Tartary Buckwheats. (Grown at Lancaster County Tobacco Experiment Station, 1946).

Buckwheat is ordinarily seeded for grain production in late June or early July. Good yields of rutin were obtained in Pennsylvania by seeding on May 13 (Fig. I); the rate of growth was slower in early plantings but the percentage of rutin was higher. Seeding on June 13 and August 1 gave larger plants, but the percentage of rutin was progressively lower.

In 1948, four large-scale plantings of Tartary buckwheat were made on Lansdale silt loam, Montgomery County, Pennsylvania, to supply material for drying studies with a portable alfalfa drier (10). Figure II shows the rutin content of buckwheat harvested from these four plantings. Here again the buckwheat from the earliest plantings had the highest rutin content, and the rutin decreased progressively as the season progressed. Since in most cases the rutin content of leaf meals prepared by fractional drying is only slightly higher than that of the fresh plant, (Table I) to produce leaf meal of high rutin content, Tartary buckwheat must be harvested at the peak of its rutin content. The best time will vary with the season, but it will be about 4 to 6 weeks after seeding.

It is doubtful that a buckwheat meal sufficiently rich in rutin could be produced from buckwheat planted later than June. The date of planting will depend somewhat on the geographic location. Where the climate is cooler and growth is slower, planting may be delayed somewhat. Table II shows that Tartary buckwheat grown in experimental plots located in Clearfield County and Susquehanna County produced plants with 5.0 to 5.6% rutin when planted in June. Plants

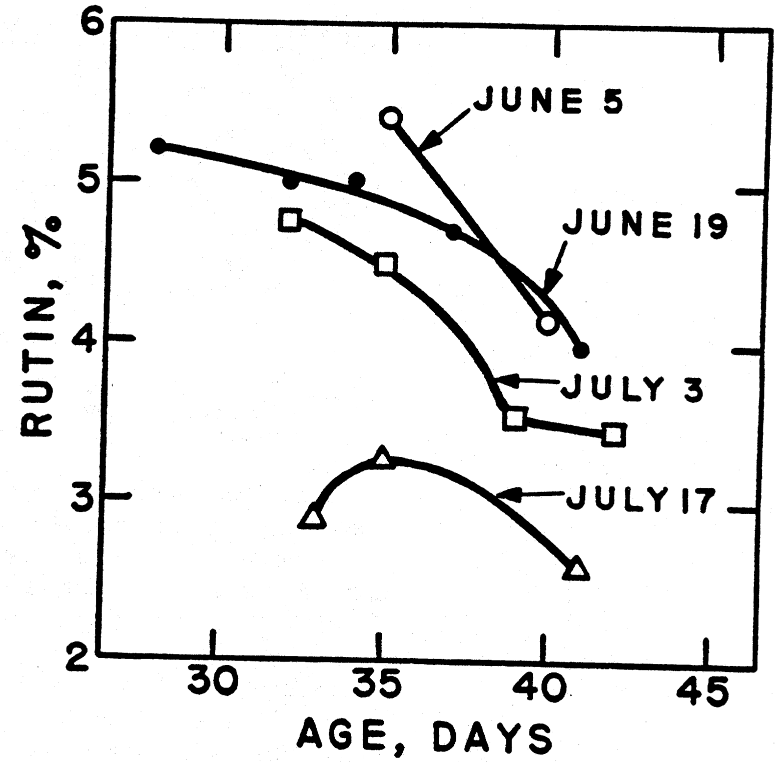


FIGURE II. Effect of Date of Planting on Rutin Content of Tartary Buckwheat.

grown on plots in Montgomery County had a slightly lower rutin content. This may have been due in part to the warmer climate. It has been reported by others (1, 2) that the flavonol content of plants increases with altitude. Additional work must be done to determine the full effect of climatic and agronomic conditions. Another reason for the lower rutin content is the greater fertility of the Lansdale silt loam, which produced plants with greater proportion of stem to leaf.

*Effect of Fertilization on the Rutin Content of Buckwheat Plants:* Experiments to evaluate the requirements of the major fertilizing elements—nitrogen, phosphorus and potassium—were carried out by the Pennsylvania Agricultural Experiment Station and the Department of Agriculture (13). On the better soils, phosphorus was the only fertilizer necessary to produce good growth of the buckwheat plants; on less fertile soils, nitrogen was also needed for adequate growth.

## TABLE II

YIELDS OF RUTIN, STEMS AND LEAVES BY TARTARY BUCKWHEAT ON DEKALB, VOLUSIA AND LANSDALE SILT LOAM

| | Dekalb Silt Loam Clearfield County [1] | | | Volusia Silt Loom Susquehanna County [1] | | Lansdale Silt Loom Montgomery County [2] | | | |
|---|---|---|---|---|---|---|---|---|---|
| Age, days | 41 | 54 | 66 | 49 | 62 | 34 | 40 | 50 | 55 |
| Moisture, % | 88.3 | 83.9 | 78.2 | 87.3 | 80.5 | 86.7 | 84.1 | 78.8 | 76.5 |
| Rutin, % (m.f.b.) | 5.6 | 5.0 | 3.4 | 5.0 | 3.4 | 4.6 | 4.5 | 3.4 | 3.0 |
| Rutin, lbs. per acre | 56 | 188 | 196 | 141 | 231 | 188 | 248 | 238 | 220 |
| Stems, lbs. per acre (dry weight) | 400 | 2450 | 4590 | — | 5260 | — | 3620 | — | 5570 |
| Leaves, lbs. per acre (dry weight) | 600 | 1300 | 1180 | — | 1520 | — | 1930 | — | 1740 |
| Leaves, % whole plant | 60 | 35 | 21 | — | 22 | — | 35 | — | 24 |

1 Buckwheat planted in June 1947 (5).

2 Buckwheat planted in June 1948; average of the two nitrogen treatments; plants one inch apart in row (13).

In none of the experiments did fertilization increase the percentage of rutin in the plant.

Other factors not yet evaluated in connection with improving the rutin content of buckwheat include the proper balance of trace elements, altitude and soil conditioners.

### Possibility of Separating Leaves from the Fresh Plant

In all large-scale studies on the rutin content of buckwheat plants, the leaves have been separated by fractionally drying. This process results in a 25 to 35% loss of rutin. This loss could be avoided if the rutin were extracted from the fresh plant. To decrease bulk, however, it would be preferable to separate and extract only the leaves. No information is available on the feasibility of separating the leaves from the fresh plant. It seems practical, however, that a process could be developed for utilizing air elutriation, such as is used to fractionate other materials of different densities. It should be possible to detach the leaves from the stems by the simple expedient of cutting the plants into one- to two-inch lengths in a forage chopper, as has been done in the past in harvesting the buckwheat preparatory to drying. Air elutriation should separate this chopped material into a leaf fraction and a stem fraction. This type of separation should have advantages not only for extraction of fresh material but also for the drying process. The reduction in bulk would increase the capacity of the driers from 2 to 3 times. Moreover, it would produce significant saving in fuel costs by reducing the amount of water removed. For even under the optimum conditions of fractional drying, the stems are dried to 25 to 35% moisture, which means that about three-fourths of the water contained in the stems is removed.

Furthermore, because the leaves contain less moisture than the stems, (9) a leaf fraction would have a high content of dry matter. This would further increase drier output. Since the wet stems in the drier retard the drying of the leaves, the rate of through-put in drying would be considerably greater for a leaf fraction, and possibly lower temperatures could be used effectively. Whether this would reduce loss of rutin can be determined only by further study.

The greatest advantage of producing a fresh leaf fraction is the concentration of rutin that can be effected. In a previous publication (9) we showed that by stripping the leaves by hand from buckwheat plants containing only 3.6 to 4.3% rutin, a leaf fraction having 6.3

to 6.4% rutin could be produced. This means that the rutin content was about 50 to 80% more than that of the whole plant. Assuming that the same enrichment could be realized with buckwheat containing 5.0 to 5.6% rutin (Table II), the expected rutin content of the fresh leaf fraction would be 7.5 to 10%. Such material would definitely hold promise as a commercial source of rutin. Unfortunately, emphasis in previous studies was placed on obtaining maximum yield of dry matter per acre, and no data were obtained on the rutin content of the leaf fraction.

Whether buckwheat may be capable of staging a comeback will most likely depend on such factors as: (1) the possibility of producing buckwheat plants that consistently contain 5% or more of rutin, (2) the feasibility of separating the leaves from the stems in the fresh state, (3) climatic and agronomic conditions that will increase the rutin content of the buckwheat plant and (4) increasing the rutin content either by selection or breeding of buckwheat.

The data and speculations presented here indicate that buckwheat is a potentially satisfactory commercial source of rutin in the United States. It is suggested that manufacturers of rutin seriously reevaluate this readily available source, and attempt to assist in the preparation of a better raw material to be produced in accordance with their needs.

## Summary

Buckwheat leaf meals can be produced with sufficiently high rutin content to compete favorably with imported rutin-bearing plant materials. To obtain plants containing a high percentage of rutin, tartary buckwheat should be planted early in the season and harvested in the blooming stage. Fractional drying enables concentration of the leaf and blossom fraction, which contains most of the rutin.

Development of a process for mechanical separation of the leaves from the stems of buckwheat in the fresh state is suggested as an immediate possibility for preparing a product with an exceptionally high rutin content. Other factors not yet evaluated in connection with increasing the rutin content of buckwheat include proper balance of trace element nutrients, the altitude at which the plants are grown, and soil conditioners.

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